RAT Selection Algorithms for Common Radio Resource Management

A Thesis presented to
the Faculty of Engineering and IT
at the University of Technology, Sydney

In accordance with
the requirements for the Degree of
Doctor of Philosophy

by
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July 2011

CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged with the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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ACKNOWLEDGMENTS

First of all, I would like to express my sincere gratitude to A/Prof. Kumbesan Sandrasegaran, who has directed and mentored my research work greatly. A/Prof. Sandrasegaran helped me in many ways that supported, encouraged and motivated me during the pursuit of my PhD degree. His endless efforts made sure that both the flexibility of choosing research topics and the correct research direction.

I would like to give my special thanks to the Commonwealth Scientific and Industrial Research Organization (CSIRO) Information and Communication Technologies (ICT) center, who partially sponsored my research work.

I would like to give my special thanks to my thesis co-supervisors Mr. Anthony Kadi and Dr. Maged Elkashlan, who guided and helped me on my research work.

I would like to thank the University of Technology, Sydney and the Faculty of Engineering and IT for their support through the APA scholarship and sponsoring my conference trips.

I would like to extend my appreciation to my fellow officemates: Mo Li, Rachod Patachaianand, Xiaoan Huang, Prashant Gami, Huda Adibah Mohd Raml, Minjie Xue, Chris Lin, and Lu Chen.

Finally, I would like to give grateful thank to my parents, Jiaming and Guopei, who supported and encouraged me to achieve as high education as they can.

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ABBREVIATIONS

1G	First Generation
2G	Second Generation
3G	Third Generation
3GPP	3rd Generation Partnership Project
4G	Fourth Generation
AC	Admission Control
APC	Access Point Controllers
ATLB	Adaptive Threshold Load Balancing
BLER	BLock Error Rate
BLJRRME	Base Layer Joint Radio Resource Management Entity
BS	Base Station
BSC	Base Station Controller
CA	Collision Avoidance
CBR	Constant Bit Rate
CC	Congestion Control
CN	Core Network
CRRM	Common Radio Resource Management
CSMA	Carrier Sense Multiple Access
DR	Direct Retry
FDMA	Frequency Division Multiple Access
FSD	Fuzzy Selected Decision
GERAN	GSM/EDGE Radio Access Network
GPRS	General Packet Radio Service

GSM	Global System for Mobile Communication
HC	Handover Control
HO	Handover
HSDPA	High Speed Downlink Packet Access
HSPA	High Speed Packet Access
HSUPA	High Speed Uplink Packet Access
JRRM	Joint Radio Resource Management
IN	Indoor
LB	Load balancing
LTE	Long Term Evolution
MADM	Multiple Attribute Decision Making
MCDM	Multi-Criteria Decision Making
MCS	Modulation and Coding Scheme
MODM	Multiple Objective Decision Making
MRRM	Multi-access Radio Resource Management
MS	Mobile Station
NCCB	Network Controlled Cell Breathing
NRT	Non-Real Time
OSM	Operator Software Module
PC	Power Control
PS	Packet Scheduling
QoS	Quality of Service
RAT	Radio Access Technology
RNC	Radio Network Controller
RRM	Radio Resource Management
RRME	RAT Resource Management Entity
RRU	Radio Resource Unit

RT	Real Time
SIR	Signal to Interference Ratio
SMD	Semi-Markov Decision
TDMA	Time Division Multiple Access
UE	User Equipment
ULJRRME	Upper Layer Joint Radio Resource Management Entity
UMTS	Universal Mobile Telecommunications System
USaBS	User Satisfaction Based Selection
USaLOR	User Satisfaction with Low Resources Selection
USM	User Software Module
UT	User terminal
UTRAN	Universal Terrestrial Radio Access Network
VG	Voice GERAN
VHO	Vertical Handover
VoIP	Voice over IP
VU	Voice UTRAN
WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless Local Area Network
WMAN	Wireless Metropolitan Area Network
WWAN	Wireless Wide Area Network

ABSTRACT

The future wireless network is expected to be a heterogeneous network, which integrates different Radio Access Technologies (RATs) through a common platform. A major challenge arising from the heterogeneous network is Radio Resource Management (RRM) strategy. Common RRM (CRRM) has been proposed in the literature to jointly manage radio resources among a number of overlapped RATs in an optimized way. RAT selection algorithm is one of the key research areas in CRRM. In the literature, a number of RAT selection algorithms have been proposed and some performance evaluations have been conducted. However, this area still has many challenges. Some performance metrics still have not been evaluated well and the existing algorithms can be further improved.

In this thesis, some performance evaluations on a number of RAT selection algorithms have been carried out. The effects of load threshold setting on Load Balancing (LB) based RAT selection algorithm's performance are evaluated. It is found that setting a proper load threshold can achieve a more balanced load distribution among overlapped cells. However, it will also cause higher Direct Retry (DR)/Vertical Handover (VHO) probability and in turn higher overhead and blocking/dropping probability.

This thesis evaluates the performance of three RAT selection algorithms, LB based using maximum resource consumption, LB based using minimum resource consumption, and service based algorithms, in terms of traffic distribution, blocking probability, throughput, and throughput fairness for a co-located GERAN/UTRAN/WLAN network. Simulation results show that in terms of blocking probability, the service based algorithm is the worst one when the traffic load is high. In terms of data throughput, the LB based using maximum resource consumption algorithm performs

better than the other two when the traffic load is low. However, the service based algorithm outperforms the other two when the traffic load is high. In terms of throughput fairness, the service based algorithm achieves the best performance.

The relationship among overall downlink data throughput, user satisfaction rate, and path loss threshold is studied in this thesis. It is found that in some cases, an optimum path loss threshold value can be found to achieve better performance in terms of both overall throughput and user satisfaction rate. However, in other cases, a tradeoff has to be made between them.

This thesis studies policy based RAT selection algorithms for a co-located UMTS-/GSM network. A three-complex policy based algorithm called IN*VG*Load algorithm is proposed based on improvements on the existing IN*VG algorithm. The simulation results show that the IN*VG*Load algorithm can optimize the system performance in highly loaded co-located UMTS/GSM networks. A Proposed Policy Based Algorithm 2 is found to be suitable for low to medium loaded UMTS/GSM networks.

In order to support the conceptual development of RAT selection algorithms in heterogeneous networks, the theory of Markov model is used. This thesis proposes both user level and network level Markov models for a co-located GERAN/UTRAN/WLAN network. The proposed Markov models are not only extensions of the existing two co-located RATs models but more complex with more state transitions. The performance of two basic RAT selection algorithms: LB based and service based algorithms are evaluated in terms of call blocking probability. The numerical results obtained from the proposed network level Markov model are validated by simulation results.